

# Signal processing and SNR calculation, as applied to chronic electrophysiology experiments

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Updated date: May 9, 2023

An abbreviated version of this protocol was published in Science Advances in Mar 2023  
Functional neurological restoration of amputated peripheral nerve using biohybrid regenerative bioelectronics  
DOI: 10.1126/sciadv.add8162

## Detailed protocol

### Signal processing and SNR calculation, as applied to chronic electrophysiology experiments (Figure 4):

Biohybrid device signals were produced by referencing pairs of electrodes within the MEA allocated randomly. Referencing was carried out by subtracting the recorded signal from one of the two electrodes of the pair from that of the other one, and was applied during processing and analysis in Matlab. From the two rats analysed, the electrode pairs over which referencing was done were the following:

Rat #1:

- Bipolar pair #1: Electrodes 0 & 7
- Bipolar pair #2: Electrodes 8 & 29
- Bipolar pair #3: Electrodes 28 & 31

Rat #2:

- Bipolar pair #1: Electrodes 9 & 14
- Bipolar pair #2: Electrodes 12 & 21
- Bipolar pair #3: Electrodes 11 & 22

These electrode numbers correspond to the following numbering scheme for the implant MEA:

	6	7	23	22	
5	26	25	9	10	21
4	27	28	12	11	20
29	3	2	18	19	13
1	30	31	15	14	17
	0	24	8	16	

These referenced signals were then bandpass-filtered (0.5 – 4 kHz, 4th order Butterworth filter). Signal-to-noise ratio (SNR) was calculated as the ratio of the variance during high signal relative to background activity, both identified manually, expressed as dB. This was carried out by first identifying three periods of high signal activity, usually corresponding with the animal leaning on or stepping with their paw. Secondly, a period of quiet baseline activity was identified within the same recording session, usually when the animal was standing still. These periods were identified by experimenters by eye. The standard deviation of these identified signal ( $\sigma_S$ ) and noise ( $\sigma_N$ ) portions of the traces were calculated. For signal, the mean standard deviation of the three identified signal periods was used to determine  $\sigma_S$ . SNR for each trace was then calculated using the following formula:

$$SNR(dB) = 10 \log_{10} \left( \frac{\sigma_S^2}{\sigma_N^2} \right)$$

**How to cite:** (Readers should cite both the Bio-protocol preprint and the original research article where this protocol was used)

- Carnicer-Lombarte, A., Malliaras, G. and Barone, D. (2023). Signal processing and SNR calculation, as applied to chronic electrophysiology experiments. Bio-protocol Preprint. [bio-protocol.org/prep2284](https://doi.org/10.21203/rs.3.rs-2822844/v1).
- Rochford, A. E., Carnicer-Lombarte, A., Kawan, M., Jin, A., Hilton, S., Curto, V. F., Rutz, A. L., Moreau, T., Kotter, M. R., Malliaras, G. G. and Barone, D. G. (2023). Functional neurological restoration of amputated peripheral nerve using biohybrid regenerative bioelectronics. Science Advances 9(12). DOI: [10.1126/sciadv.add8162](https://doi.org/10.1126/sciadv.add8162)

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